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Two new species of *Acromastigum* (Lepidoziaceae: Jungermanniopsida) from Queensland, Australia

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Abstract

As a result of fieldwork on Cape York Peninsula, and ongoing revision of type specimens in lieu of the recent revision of Australian *Acromastigum,* two new species are described. *Acromastigum carcinum* represents a newly discovered species, currently known only from one location within the Jardine River National Park. The lowland and tropical monsoonal habitat of this species is highly unusual within the genus, and hints at the existence of a distinct, if species poor, bryofloristic element within tropical monsoon lowland habitats. *Acromastigum implexum* has been long recognised in Australia under the name *A. echinatiforme*, however comparison with the original material of that species confirms Australian plants represent a distinct species. *Acromastigum implexum* inhabits tropical montane rainforest habitats. Both species are currently known only from Australia, but both, particularly *A. carcinum*, may occur in similar habitats overseas.

Introduction

Australian species of the genus *Acromastigum* were revised by Brown and Renner (2014), wherein 12 species, including three new species, were recognised. This work was published in June 2014, eight months after the untimely death of Dr Elizabeth Brown. Following the publication of that revision, during the course of fieldwork on Cape York Peninsula a species of Lepidoziaceae subfamily Bazzanioideae Rodway was collected alongside a small, permanent, tributary of Elliot Creek within Jardine River National Park (Fig. 1). This plant had conspicuously bilobed leaves and trifid underleaves, but was not immediately referrable to any species of *Acromastigum* or *Bazzania*, and its generic placement could not be established in the field. It was not until the plant was examined under a compound microscope that a terminal origin for the geotropic stolons was confirmed, placing the plant within *Acromastigum*. We present this as a new species of *Acromastigum* since it does not match any species described by Evans (1934) or Grolle (1964, 1978), and does not match any type material held in Geneva. That such a distinctive species has only been recently discovered can perhaps be reconciled against the focussed effort towards bryophyte collecting in the Wet Tropics, particularly at higher altitude montane regions where bryophyte biomass and diversity are known to be high.

In the same vein, the lowland tropical monsoon habitats of Papua New Guinea and Australia have received little attention because of their comparatively low bryophyte biomass and species diversity. One of the new *Acromastigum* species suggests that there might be a small but distinct suite of lowland monsoon specialists.

With regards to *A. echinatiforme* (De Not.) A.Evans, Brown and Renner (2014 p. 281) noted that there were 'significant differences between Australian and Malesian populations of *A. echinatiforme*' in leaf dimensions, but followed determinations made by Hicks and accepted that the species was in Australia because they had not seen the type (Brown and Renner 2014). Following examination of type material at Geneva, it became clear that Australian specimens have been incorrectly attributed to *A. echinatiforme*. In addition to differences listed by Brown and Renner (2014), Australian plants differ from the Malesian type in leaf and underleaf lobe width such that the type falls outside the range of variation seen in Australian plants. Therefore, we consider that the differences between Australian specimens and the type of *A. echinatiforme* are best explained by the existence of two species. A new species is proposed for Australian plants as a formal placeholder for this hypothesis of relationships.

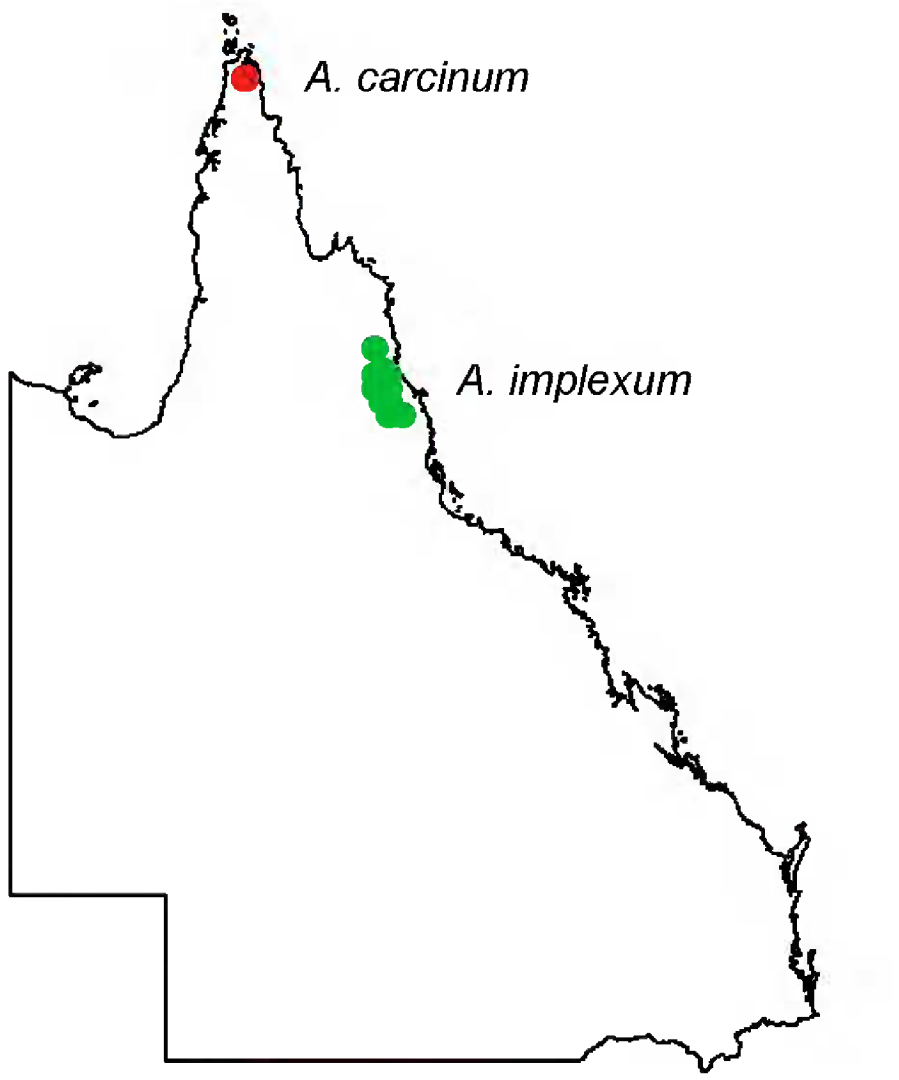

Fig. 1. Generalised distribution of *Acromastigum carcinum* and *A. implexum*.

Material and Methods

Field collected and herbarium specimens were studied and compared with types, literature, and vouchers determined as part of the revision presented by Brown and Renner (2014) and held in NSW.

To quantify variation in leaf and underleaf form, and identify discontinuities contributing to species circumscription for *Acromastigum echinatiforme*, we made counts of cell number for three variables: leaf disc length, postical lobe width, and largest underleaf lobe width. Twenty counts for each variable were made from each specimen, the sample set included the type of *A. echinatiforme* and four specimens of *A. implexum* from Queensland.

Taxonomy

Acromastigum carcinum M.A.M.Renner & T.C.Wilson, ***sp. nov.***

Diagnosis: *Acromastigum carcinum* can be recognised by its large shoots up to 1.8 mm wide; deeply three-lobed underleaves that are three to four times as wide as the stem and whose lobe apex is bicornute; asymmetrically bilobed leaves with lobes unequally-sized and forward-swept, separated by a narrow V-shaped sinus whose apex lies on the leaf midline; irregular leaf outline with projections and shallow notches; large leaf cells with conspicuous bulging trigones, wherein both a primary and secondary wall are visible; mamillose cells whose projecting mamillae form a crenulate margin.

Type: Australia: Queensland: Cook District, Cape York Peninsula, Jardine River National Park, Elliot Creek, 53 m, 11°22'54.7"S 142°24'47.8"E, 8 August 2015, *M.A.M.Renner 7353 & T.C.Wilson* (holotype: NSW 992696, isotypes: BRI, CANB, F, G)

Forming loose mats of procumbent shoots, yellow-green and lacking brown pigments. Shoots 1.2–1.8 mm wide, 10–20 mm long. Stems 150–225 μm diameter, slightly dorsi-ventrally flattened; cortical cells 22–44 μm diam. in 7 or 8 rows; medullar cells 14–21 μm diam. in 8–12 rows; cortical cells with thick walls, outer and inner tangential walls 6–11 μm thick, radial walls narrower (2–8 μm); medullar cells thinner walled, typically 1–3 μm thick. Vegetative branches arising at intervals of 5 mm, diverging at an angle of 40–60(–90)°; geotropic stolons frequent, leaves bifid, microphyllous at branch base, decreasing in stature and becoming scale-like; rhizoids scarce. Leaves inserted at an angle of 60° from the vertical, imbricate, elliptic ovate, 740–840 μm long × 460–510 μm wide, widest at base, dorsal base auriculate, ventral margin shallowly curved, margins irregular; leaves bilobed, dorsal lobe broadly triangular, nearly isosceles, 147–171 μm long, 151–184 μm wide, apex acute; ventral lobe falcate, swept forward, 6–8 cells wide at base, 240–297 μm long, 177–202 μm wide at base, apex acute. Vitta present but poorly defined, extending from middle of leaf at base toward the leaf sinus apex, 5 or 6 cell rows wide at base, narrowing to 4 or 3 cell rows toward the leaf apex, separated from ventral leaf margin by 4 or 5 cells rows, vitta cells oblong, 25.1–46.5 μm long by 11.9–17.3 μm wide, with large, bulging trigones comprised of primary and secondary wall, with the two wall types visible within the trigone; medial wall thickenings absent; medial cells broadly elliptic, with long axis radiating toward leaf margin from the middle of the leaf base, 13.5–22.4 μm long by 11.8–16.5 μm wide, trigones as for basal cells; marginal cells 10.3–18.6 μm long by 7.9–12.8 μm wide; medial and marginal cells mamillose. Cuticle with scattered low papillae on medial and marginal cells, denser on lobe cells. Oil-bodies unknown. Underleaves 4 or 5 times wider than stem, imbricate, insertion ±transverse, 412–508 μm long by 610–723 μm wide, rounded at base, marginal irregularities frequent; 3-lobed, sinuses to c. 0.66 of underleaf length, disc 4–6 cell tiers high, lobes unequal, largest lobe (290–384 μm long) on one side, shortest lobe (265–329 μm long) on opposite side, lobes variously 6–12 cells wide at base, apex emarginate or bicornute. Asexual reproduction absent. Sexual reproductive structures not seen. **Fig. 2.**

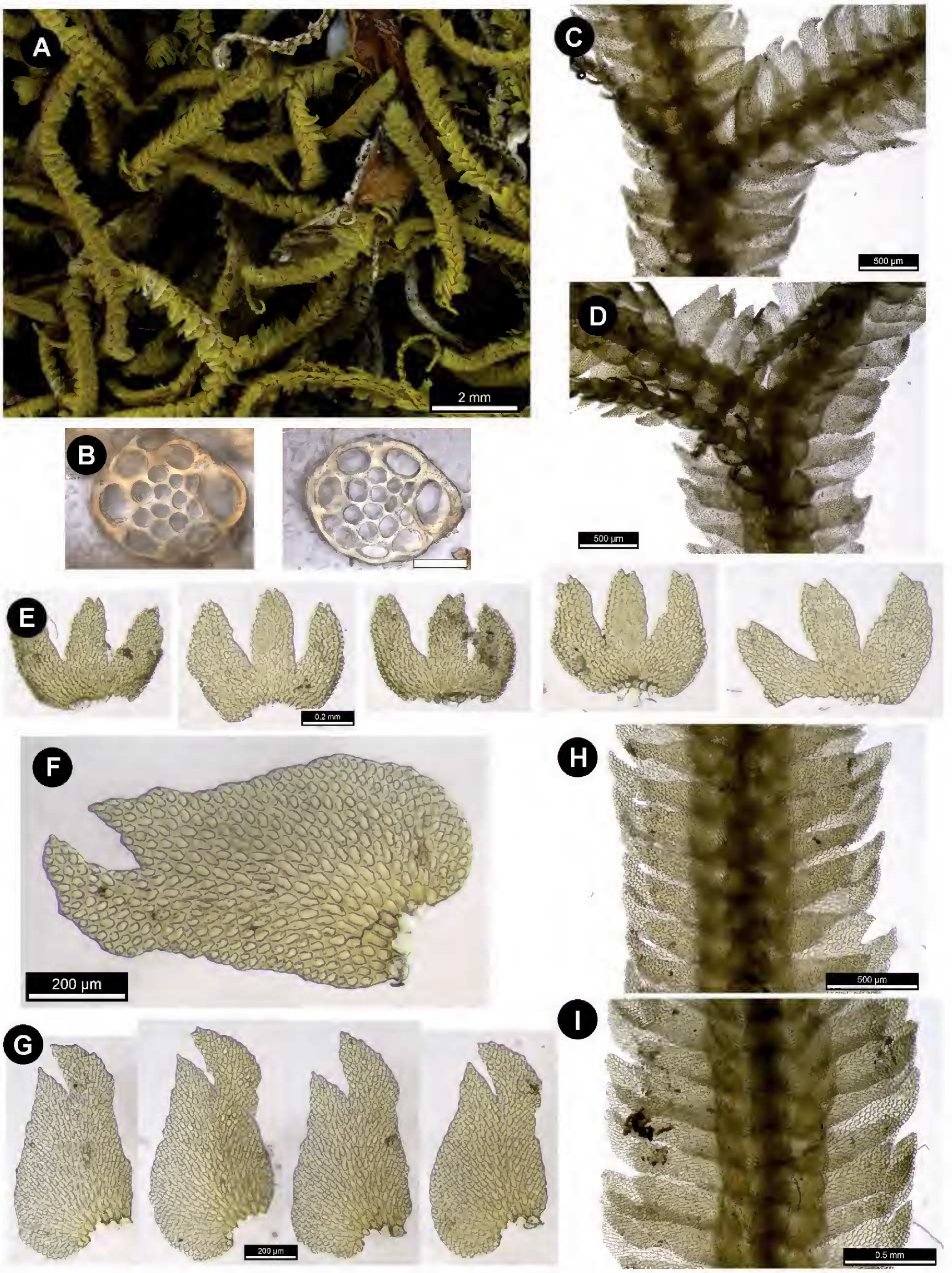

Fig. 2. *Acromastigum carcinum.* **A,** Habit of dry specimen. **B,** Two sections of leafy stems. **C,** Branch in dorsal view, showing pseudodichotomous branching in which the smaller branch only partially displaces the larger main shoot. **D,** Branch in ventral view. **E,** Five underleaves, showing distinct lobes with bicornute apex and weak asymmetry. **F,** Leaf, showing cellular detail in particular the coarse trigones present throughout the leaf; note the weakly defined medial vitta and radial orientation of cell long axes above and below, and the transition to isodiametric cells at the leaf margin. **G,** Four leaves showing the distinctive shape with the unequally-sized and forward-swept lobes. **H,** Shoot sector dorsal view. **I,** Shoot sector ventral view; note the underleaf width relative to the stem. All from *NSW 992696*.

Fig. 3. Tributary of Elliot creek showing small falls in permanent waterway next to which *A. carcinum* grew (upper), and the growth habit of *A. carcinum* showing the dull bronze-green colour and loose mats formed by overlapping shoots.

Distribution and ecology: *Acromastigum carcinum* is currently known from a single locality, a small tributary of Elliot Creek in Jardine River National Park, Cape York Peninsula, Queensland (Fig. 3). At this site *A. carcinum* grows within the flood channel of a small permanent stream flowing through sandy soils and exposed pavements derived from sandstone. It is restricted to the proximal spray zones associated with small chutes, cascades, and riffles. This species forms small bright yellow-green carpets on dark humus covering vertical surfaces of the stream bank and in sheltered recesses stabilised by other vegetation overhanging the stream. Several discrete patches were noted along some 50 metres of stream length. The stream flows through open shrubby tropical woodland to 10 metres tall consisting of emergent *Allocasuarina littoralis* (Salisb.) L.A.S.Johnson and *Callitris intratropica* R.T.Baker & H.G.Sm., over a mixed discontinuous canopy with *Choriceras tricorne* (Benth.) Airy Shaw, *Corymbia clarksoniana* (D.J.Carr & S.G.M.Carr) K.D.Hill & L.A.S.Johnson, *Grevillea pteridifolia* Knight, *Melaleuca viridifolia* Sol. ex Gaertn., *Xanthostemon crenulatus* C.T.White, with a subcanopy and shrub layer dominated by *Acacia* spp., *Asteromyrtus lysicephala* (F.Muell. & F.M.Bailey) Craven, *Jacksonia thesioides* A.Cunn. ex Benth., *Neofabricia myrtifolia* (Gaertn.) Joy Thomps., *Thryptomene oligandra* F.Muell., and a ground layer with *Baloskion tetraphyllum* subsp. *meiostachyum* (L.A.S.Johnson & O.D.Evans) B.G.Briggs & L.A.S.Johnson, *Drosera* spp., *Lomandra banksii* (R.Br.) Lauterb., *Lycopodiella cernua* (L.) Pic.Serm., *Nepenthes mirabilis* (Lour.) Druce, *Pteris* sp., *Schoenus sparteus* R.Br., *Sticherus flabellatus* (R.Br.) H.St.John, *Stylidium floodii* F.Muell. and other graminoids. The ground layer was particularly dense in close proximity to the stream. An unidentified species of *Riccardia* was also found growing with *A. carcinum*.

Acromastigum carcinum may occur in other lowland monsoon habitats on both sides of the Torres Strait. Liverworts within these habitats have been poorly documented as collecting efforts in both Australia and Papua New Guinea have focussed on wetter, cooler habitats of high bryophyte diversity.

Identification: The greatest challenge to the identification of *Acromastigum carcinum* is generic assignment. The ventral *Acromastigum*-type geotropic stolons produced by *A. carcinum* are leafy at their base (Fig. 2D). The first branch leaf is set at the very base of the branch, on the postico-lateral side opposite the half-underleaf. These two segments may overlap, such that the branch origin is obscured, making it difficult to decide whether the plant belongs in *Bazzania* or *Acromastigum*. The large size of *A. carcinum* is unusual for the genus within Australia, which may contribute to confusion. The bilobed leaves are consistent with *Acromastigum*, but bilobed *Bazzania* species are known.

Under high magnification, the terminal origin of the geotropic stolons can be established by their placement next to a half-underleaf, typically a single lobe, rarely bilobed.

In the field, the branch origin is nearly impossible to establish because surrounding underleaves overlap with and obscure the branch base. However, *A. carcinum* can still be identified with confidence in the field as well as the laboratory by a range of distinctive characters. The underleaves of *A. carcinum* are deeply three-lobed and three to four times as wide as the stem (Fig. 2E, I). In all other Australian species of *Acromastigum* the underleaves are the same width as, or only slightly wider than the stem, and in most species are obscurely lobed. Only *A. colensoanum* and *A. implexum* have underleaves as deeply divided, but in neither are the underleaves as wide, nor do the lobes spread widely. Under the microscope the underleaf lobe apex in *A. carcinum* is often bicornute (Fig. 2E), formed by two prominent, pointed cells at the apex that are separated by a sinus.

The leaves of *A. carcinum* are distinctive in shape, with the unequally-sized and forward-swept lobes, and the narrow, V-shaped sinus whose apex lies on the leaf midline (Fig. 2F, G). Some leaves are nearly rectangular in outline when flattened, due to the way in which the postical leaf-lobe is curved and pointed forward (Fig. 2F,G). The antical leaf-lobe is broadly triangular, and acute. The leaf outline is irregular, with bumps and shallow notches, and the interior margin is broadly ampliate (Fig. 2F).

The leaf cells are large and have conspicuous bulging trigones (Fig. 2F) comprised of primary and secondary wall, with the two wall types visible within the trigone. The cells are mamillose, and on the margin the mamillae may project making the margin crenulate. The vitta is poorly defined but comprises four or five rows of cells that extend up the middle of the leaf (Fig. 2F). Among Australian *Acromastigum* this combination of characters is found only in *A. carcinum*.

Acromastigum bifidum (Steph.) A.Evans (type: Ferguson Island, D'Entrecasteaux, May 1895, *Micholitz* G00067274!) is another large species, but has toothed leaf margins that immediately distinguish it from *A. carcinum*.

Etymology: *carcinum* from the latin variation of the Greek name for the constellation Cancer, the crab Καρκινος (Karkinos), in reference to the distinctly claw-like appearance of the leaves of this species.

Acromastigum implexum M.A.M.Renner sp. nov.

Diagnosis: *Acromastigum implexum* is distinctive in having leaves subequally-bilobed, with lobes parallel, leaf margins entire, cell walls evenly and continuously thickened; underleaves three-lobed divided to halfway or

slightly deeper, slightly wider than stem; the leaf disc is 12–23 cell tiers high, the ventral leaf lobe 3–5 cells broad at the base, and the underleaf lobes are 4–8 cells broad at their base.

Type: Queensland, Cook, Bellenden Ker Range, Wooroonooran National Park, Russel River catchment, track to Choorichillum from end of Gourka Road, between NW summit and Choorichillum, 17°23'45"S 145°48'56"E, 1460 m, 30 Mar 2012, *M.A.M. Renner 6432*, *V.C. Linis & E.A. Brown* (holotype: NSW896971; isotypes: BRI, CANB, F, G).

Description: Brown and Renner (2014) as *A. echinatiforme*. **Figs 4, 5.**

Etymology: implexum from the Latin for interwoven, in reference to the tightly knit patches of interlocked leafy and geotropic shoots formed by this species, and also the passion for quilting held by the late Dr Elizabeth Brown, who studied Australian *Acromastigum* for 25 years.

Recognition: *Acromastigum implexum* can be recognized by its subequally-bilobed leaves whose lobes are acute and have their long axis nearly parallel (Fig 4B, 5); the underleaves are 3-lobed, divided to halfway or slightly deeper, slightly wider than the stem, and the disc has a blunt tooth on either side (Fig. 4K). The leaf cell walls are continuously and evenly thickened throughout (Figs 4E–G).

Acromastigum implexum differs from *A. echinatiforme* (isosyntypes: Borneo, in monte Linga, 1867, *Beccari* ex herb Bossier ex herb Steph. G00282403! G00113667! G00282402!) in leaf and underleaf dimensions. In *A. implexum* the leaf disc is 12–23 cell tiers high, the ventral leaf lobe is 3–5 cells broad at the base, and the underleaf lobes are 4–8 cells broad at their base. In the type of *A. echinatiforme* the leaf disc is 6–10 cell tiers high, the ventral leaf lobe is 5–9 cells broad at the base, and the underleaf lobes are 4 or occasionally 5 cells broad at their base (Fig. 6).

The status of plants illustrated as *A. echinatiforme* by Grolle (1978) is unresolved.

Notes: The largest specimen among the isosyntypes of *M. echinatiforme* in Geneva (G00282403) is a mixture of two *Acromastigum* species, suggesting that lectotypification within the type series is required. The other *Acromastigum* is similar to *A. bancanum*.

Specimens examined: Australia: Queensland**:** Cook: Track to Manjal Jimalji, ridge between coral fern patch and Devil's Thumb, 16°23'32"S 145°17'35"E, 1186 m, 18 May 2014, *M.A.M. Renner 6969b & T.C. Wilson*, (NSW859384); Good Shepard Rock, slope of Mount Demi near Mossman, 16°30'S 145°19'E, 17 Jul 1983, *M.L. Hicks 11661* (NSW434075); Mount Lewis State Forest, Mount Lewis Road, third creek beyond locked gate, 16°30'16" S 145°16'08" E, 1200 m, 14 Aug 1995, *E.A. Brown 95/108, B.M. Wiecek & K.L. Radford* (NSW390610); State Forest 143, Mount Lewis Road c 30.5 km from intersection with Mossman-Mount Molloy Road, 50 m up small stream, 16°30'50"S 145°16'10"E, 16 Jul 1994, *E.A. Brown 94/500, R.G. Coveny & B. Tan* (NSW297109); Main Coast Range, 19 km NNW of Mount Molloy, 1200 m, 16°31'S, 145°16'E, 30 Jun 1984, *H. Streimann 30310* (CANB8408816); ibid, *H. Streimann 30308* (CANB8408814); Mt Bellenden Ker National Park, Mt Bellenden Ker, just below radio transmitter pylon, between track and stream, 17°15'55"S 145°51'15"E, 1500 m, 7 Aug 1995, *E.A. Brown 95/179, B.M. Wiecek & K.L. Radford* (BRI, NSW390438); Mount Bellenden Ker, south peak, 23 km SSE of Gordonvale, 1550 m, 17°18'S, 145°52'E, 3 Mar 1983, *H. Streimann 27433* (CANB8305398); Bellenden Ker Range, Russell River catchment, Wooroonooran National Park, track to Choorichillum from end of Gourka Road, between NW summit and Choorichillum, 17°23'45"S 145°48'56"E, 1460 m, 30 Mar 2012, *M.A.M.Renner 6432, V.C. Linis & E.A. Brown* (NSW896971); Massey Creek on road between Ravenshoe and Millaa Millaa, 17°36'S 145°35'E, 30 Jun 1983, *W.B. Schofield 80127 & M.I. Schofield* (NSW498527); North Kennedy: Cardwell Range, Douglas Creek, Bridge No. 10, on forestry road to Blencoe Falls, 700 m upstream from bridge, 18°12'46"S 145°48'30"E, 730 m, 30 Jul 1995, *E.A. Brown 95/74, B.M. Wiecek & K.L. Radford*, (NSW390333); 31 Jul 1995, *E.A. Brown 95/108, B.M. Wiecek & K.L. Radford*, (NSW390367).

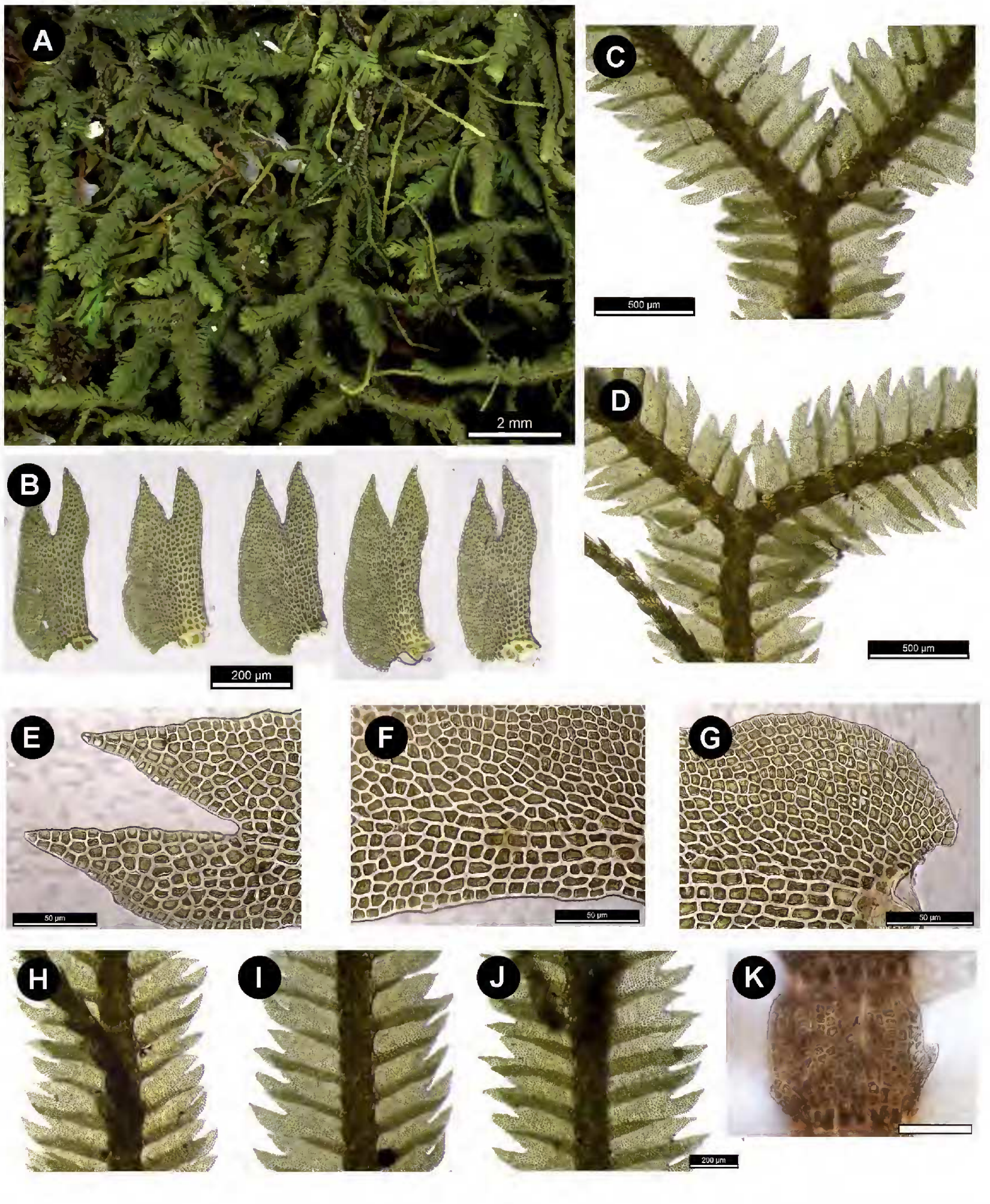

Fig. 4. *Acromastigum implexum*. **A,** Habit of dry specimen. **B,** Five leaves, dorsal margin to the left. **C,** Branch in dorsal view, showing pseudodichotomous branching in which the smaller branch displaces the larger main shoot. **D,** Branch in ventral view. **E,** Detail of leaf lobes showing cellular detail. **F,** Cells at leaf middle and on the ventral margin. **G,** Cells on the dorsal leaf margin and medial leaf base. **H,** Shoot sector in ventral view showing geotropic stolon. **I,** Shoot sector in ventral view, note underleaf width relative to the stem. **J,** Shoot sector in dorsal view. **K,** Underleaf, showing distinct lobes. All from *NSW 896971*.

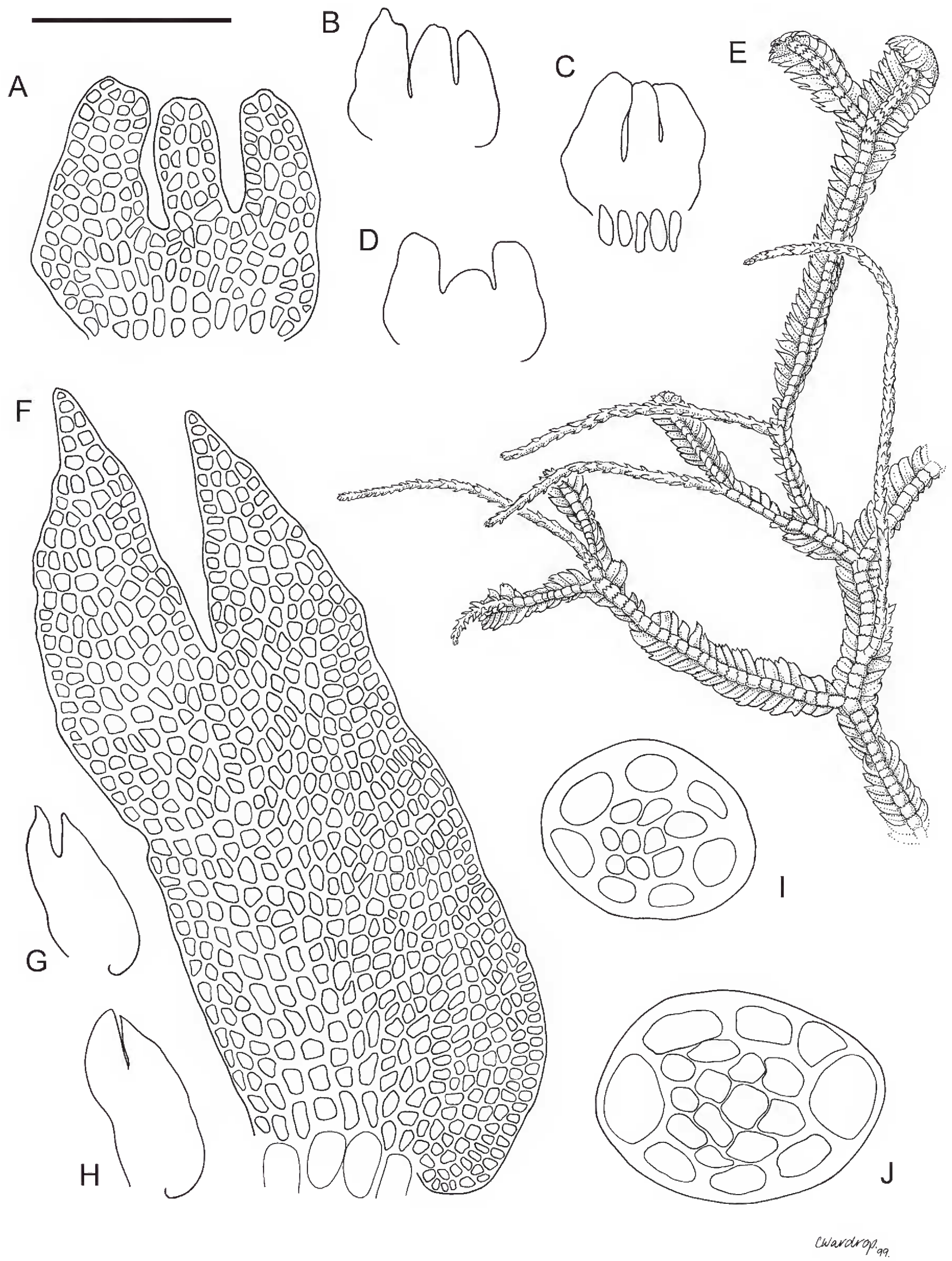

Fig. 5. *Acromastigum implexum*. **A,** Underleaf cellular detail. **B–D,** Underleaf outlines. **E,** Ventral view of shoot system. **F,** Leaf cellular detail. **G, H,** Leaf outlines. **I, J**, Stem transverse sections. Scale (approximate) **A**, **F**, **I**, **J**, 250 μm; **B–D,** 500 μm; **E,** 4000 μm; **G**, **H,** 1000 μm. From *E.A. Brown 94/500* and *Hicks 11661*.

Revised key to species

In the following couplets 11 and 15 from the key to Australian *Acromastigum* in Brown and Renner (2014) are changed and added, respectively.

11. Underleaf width equal to or less than stem; plants with or without a distinct vitta; south eastern Rainforests in New South Wales, and Victoria; and Tasmania and New Zealand **12**

11. Underleaves wider than stem; plants without a distinct vitta; Wet Tropics Bioregion Rainforests, Queensland **15**

15. Underleaves 3–4 times wider than stem, underleaf lobes spreading, apex emarginate. Leaf cells mamillose, cell walls with conspicuous bulging trigones. Leaves anisolobus, the postical lobe larger and curved, the antical lobe triangular ..... ***A. carcinum***

15. Underleaves 1.0–1.5 times wider than stem, underleaf lobes convergent to parallel, apex truncate. Leaf cells not mamillose, cell walls continuously and evenly thickened. Leaves subisolobous, both lobes narrowly triangular ..... ***A. implexum***

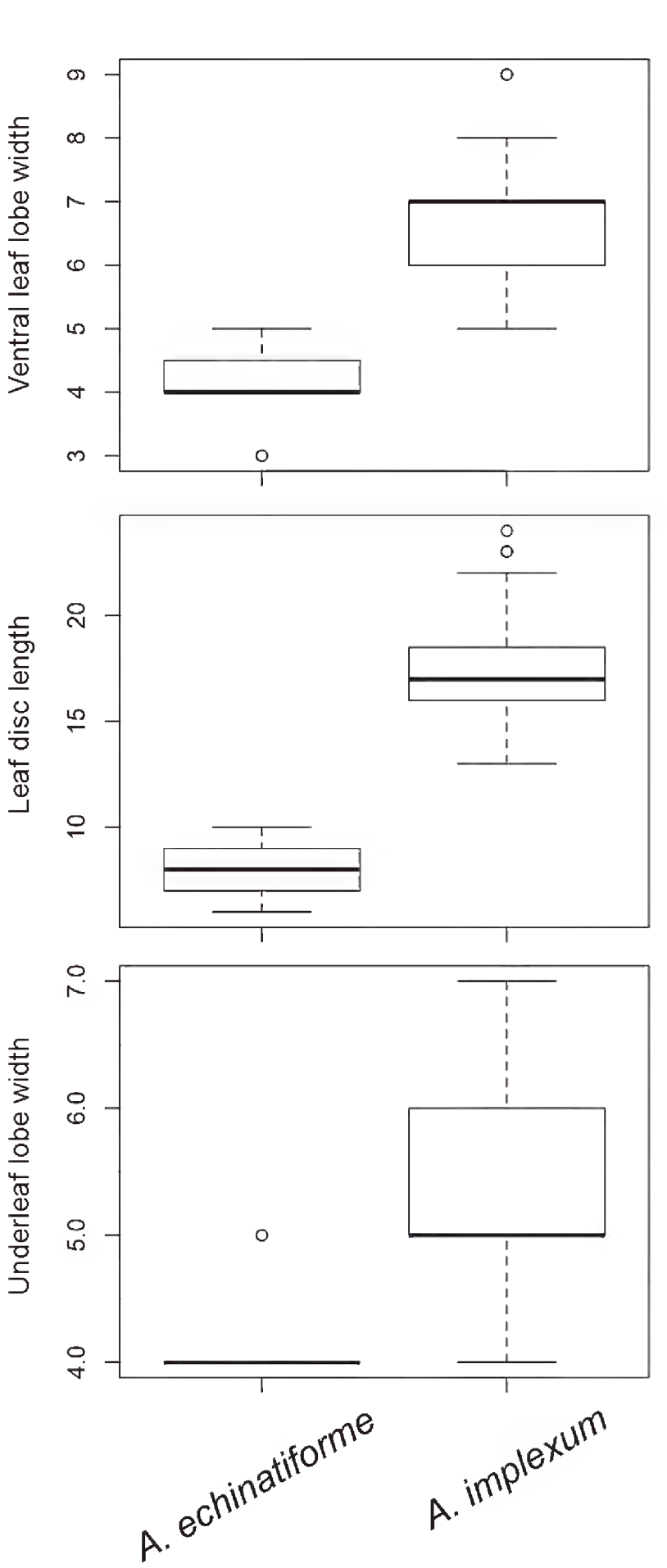

Fig. 6. Boxplots showing variation in cell counts describing the size of three structures by which the type of *A. echinatiforme* falls outside the range of variation exhibited by Australian *A. implexum*.

Acknowledgments

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